Quiz Thursday:

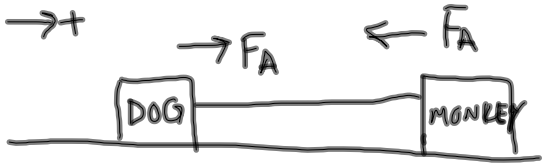
- FBDs
- Tug-of-War problems
- Net force problems
- 1-D motion (x- and y-directions)

Friction Notes and Practice Problems 3.5.12 Honors Physics

A dog (14.0 kg) and a monkey (8.0 kg) are playing tug-of-war on a frictionless surface. They are attached by a rope, and the dog pulls on the monkey's collar with a force of 55.5 N.

a) What happens to the motion of each animal?
b) Which animal receives the most force?
c) Calculate the acceleration of the monkey.

"Tug-of war" problem

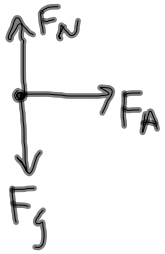


a) Dog and Monkey move towards each other

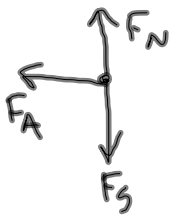
b) Both experience the same force
- Monkey will have more acceleration because it has less mass

c) Draw FBDs for both

Dog:



Monkey:



Calculate monkey's acceleration

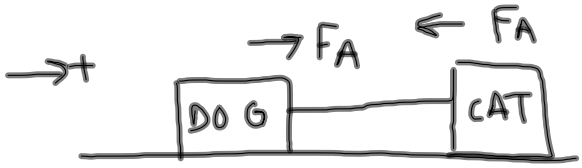
$$\Sigma \vec{F}_x = m\vec{a}_x$$

$$a_x = \frac{\Sigma \vec{F}_x}{m} = \frac{-F_A}{m}$$

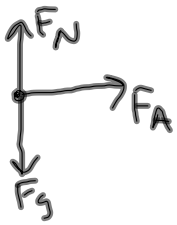
$$= \frac{-55.5\,N}{8\,kg}$$

$$= -6.94\ m/s^2$$

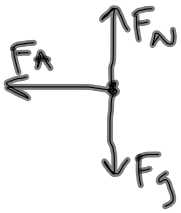
Dog ($m_d = 10$ kg) pulls on cat ($m_c = 5$ kg) with 25 N of force. Find acceleration of dog and cat. Draw FBD of both, also.



FBD dog:



FBD cat:



find a_d:

$$\Sigma \bar{F}_x = m_d \bar{a}_d$$

$$\bar{a}_d = \frac{\Sigma \bar{F}_x}{m_d} = \frac{25\ N}{10\ kg} = 2.5\ m/s^2$$

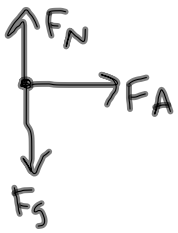
find $\bar{a}_c$:

$$\Sigma \bar{F}_x = m_c \bar{a}_c$$

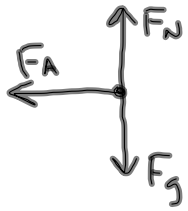
$$\bar{a}_c = \frac{\Sigma \bar{F}_x}{m_c} = \frac{-25\ N}{5\ kg} = -5\ m/s^2$$

In a game of tug-o-war on a frictionless surface, a 120.0 N dog pulls on a 65.5 N cat, making the cat accelerate at 1.42 m/s/s. What is the acceleration of the dog?

FBD dog:



FBD cat:



find mass of dog:

$$F_{gd} = m_d a_g$$

$$m_d = \frac{F_{gd}}{a_g}$$

$$= \frac{120\ N}{9.8\ m/s^2}$$

$$= 12.24\ kg$$

find mass of cat:

$$F_{gc} = m_c a_g$$

$$m_c = \frac{F_{gc}}{a_g}$$

$$= \frac{65.5\ N}{9.8\ m/s^2}$$

$$= 6.68\ kg$$

- find force applied given $a_c = -1.42\ m/s^2$

$$\Sigma \bar{F}_x = m_c \bar{a}_c$$

$$F_A = (6.68\ kg)(-1.42\ m/s^2)$$

$$= -9.48\ N$$

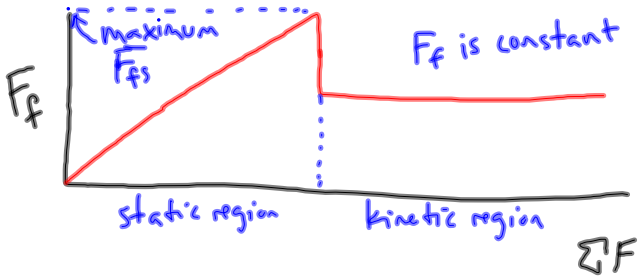
- find acceleration of dog:

$$\Sigma \bar{F}_x = m_d a_d$$

$$\frac{\Sigma F_x}{} = \frac{9.48\ N}{}$$

Force of Friction:

- Types of friction:
  - Static → object is NOT moving
  - Kinetic → object is moving



$$F_{fs} = \mu_s F_N$$

F_{fs} → force of static friction; μ_s → coefficient of friction; F_N → normal force

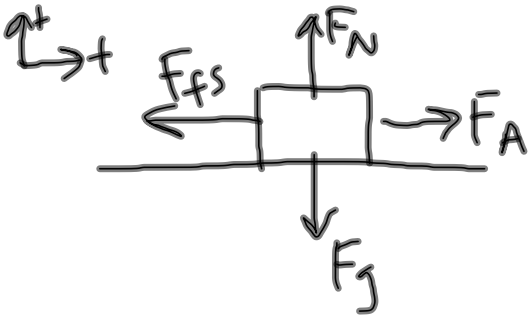
- Coefficient of friction (μ) is measure of how easily something slides.
  - Static and kinetic
  - Unitless quantity

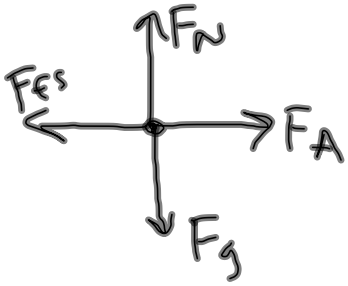
$$F_{fk} = \mu_k F_N$$

F_{fk} → force of kinetic friction; μ_k → coefficient of kinetic friction; F_N → normal force

- Direction of the force of friction is ALWAYS opposite the direction of motion

A 24 kg crate initially at rest on a horizontal floor requires a 75 N horizontal force to set it in motion. Find the coefficient of static friction between the crate and the floor.





$$F_{fs} = \mu_s F_N$$

$$\mu_s = \frac{F_{fs}}{F_N}$$

$$= \frac{75\ N}{235.2\ N}$$

$$= 0.319$$

$$\Sigma F_x = \emptyset$$

$$F_A - F_{fs} = \emptyset$$

$$F_{fs} = F_A = 75\ N$$

$$\Sigma F_y = \emptyset$$

$$F_N - F_g = \emptyset$$

$$F_N = F_g$$

$$= ma_g$$

$$= (24\ kg)(9.8\ m/s^2)$$

$$= 235.2\ N$$

A box with mass of 55 kg is being accelerated across a level floor with a force of 47 N. If the coefficient of friction between the box and floor is 0.37, what is the acceleration of the box?